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SOIL INCORPORATION SHOWS PROMISE FOR LOW COST TREATMENT OF SANITARY VAULT WASTES

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ABSTRACT.--Field tests on the Hiawatha National Forest have shown that soil incorporation of sewage vault wastes doesn't pose an environmental hazard when used in areas that are protected from public access.

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Treatment of sanitary wastes from forest campgrounds has been a difficult problem for land managers. Recent pollution control standards require that managers adopt more environmentally acceptable methods and, moreover, that they must do so within the constraints of already pinched budgets. This has stirred reconsideration of the ancient method of direct application of wastes to the soil. In August 1972, consequently, limited tests were initiated on the Hiawatha National Forest in Michigan's Upper Peninsula by the USDA Forest Service's North Central Forest Experiment Station in cooperation with Michigan Technological University. The purpose is to define soil conditions necessary for safe incorporation of vault wastes beneath the soil surface without hazardous changes in bacterial and chemical quality of ground water. The following summer (1973), these tests were extended to another site on the Hiawatha National Forest and expanded in terms of the size of study site (from about 0.2 acre to 2 acres) and amount of wastes incorporated into the soil (from 1,500 gal to 14,000 gal). This report outlines the preliminary findings after one full year following the 1972 treatments.

DESCRIPTION OF TEST SITES AND METHODS

Both test sites are located on a gently rolling (<5 percent slope) glacial sandy plain (Kalkaska sand soil). Ground water levels vary with season and rainfall. However, at the time of treatment on the initial test site, the ground water depth was 8.5 feet and the ground water flow was indicated as being southwest (azimuth, 221°).

We considered that the filtration capability of these sandy soils, together with the shallow water table, could pose conflicting conditions for successful incorporation of sanitary wastes in soils--conditions that we viewed as being moderately critical in terms of potential ground water contamination. Therefore, we feel that this method of waste treatment could be safely used on much of

the National Forest lands in the northern Lake States if our findings show that its' use doesn't contaminate ground water under the test sites.

In the initial test, waste from vault toilets was injected into the soil on August 16 and 17, 1972, using a machine that slits open a furrow, applies the waste at the bottom, and closes the furrow in one operation. The furrows were spaced approximately 2-1/2 ft apart and were approximately 6 in. deep; 0.5 gal of waste was applied per linear foot.

Approximately 100 gal were injected in area A shown in figure 1 for infiltration tests; the remaining 1,400 gal were applied on a 120 by 60 ft plot in area B. The waste material used can be characterized as follows: total solids, 2.8 percent; total Kjeldahl N, 3,860 mg/l; total P, 574 mg/l; NH_3-N, 34 mg/l; 1.74×10^6 fecal coliforms/100 ml; and 3.23×10^7 enterococci/100 ml. The indicated loading rates were 270 lb/acre for nitrogen and 40 lb/acre for phosphorus.

Six wells (1 1/4 in. diameter) were installed with screens positioned in the 3 ft layer immediately below the water table. Ground water samples withdrawn from these wells would be expected to show the maximum concentration of percolated contaminants in the surface of the saturated zone. Supplementary measurements were made using plastic filter candles that were located a few inches below the water table and connected to the surface with tygon tubing. Location of wells and filter candles in a transect from the center of the treatment plot are shown in figure 1.

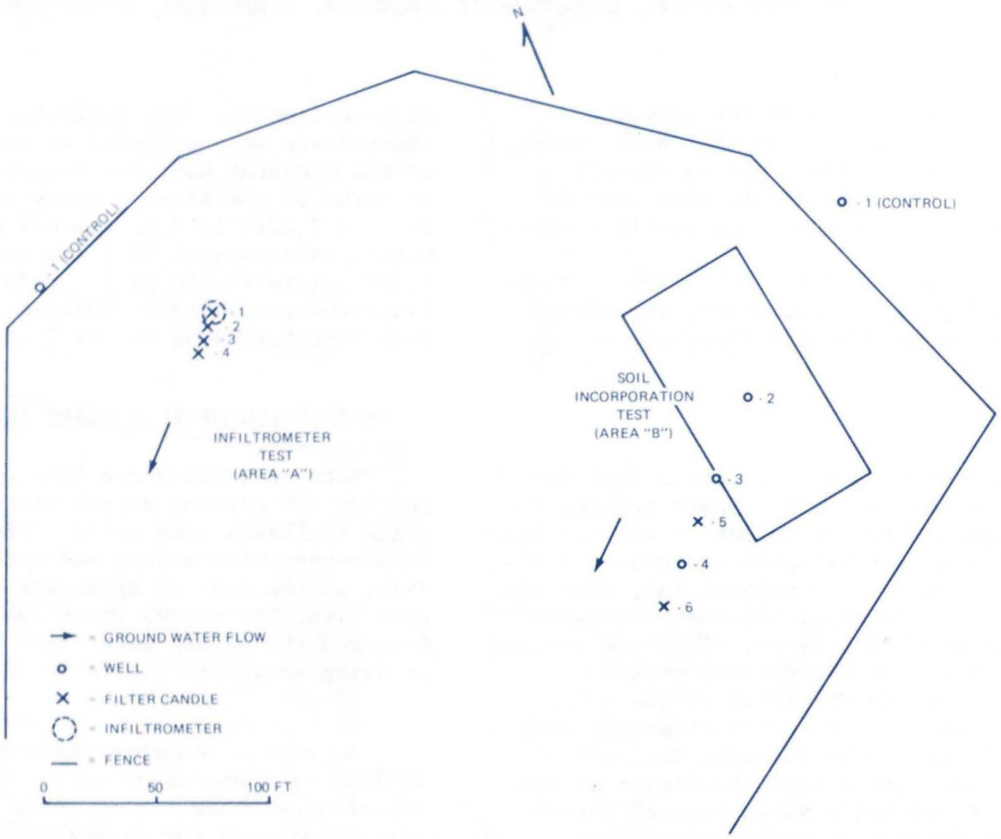

Figure 1.--*Instrumentation of soil incorporation test area and infiltrometer test area on the Hiawatha National Forest, August 1972.*

A circular 25 ft^2 single ring infiltrometer was emplaced over two furrows and irrigated with tapwater to a depth of 6.35 in. at a rate of 15 in./hr. Filter candles located within the infiltrometer and at 5, 10, and 15 ft away along the ground water flow path (fig. 1) were used to obtain water samples from which measurements of bacterial quality and chemical constituents were determined.

RESULTS

Measurements of ground water quality showed increases in nitrogen levels directly beneath treatment plots but such increases were not detected in wells 5 ft or more away in the direction of ground water flow. Indicators of bacteriological contamination were found in ground water at 6 to 8 ft depths only on the area where over 6 in. of water were applied immediately after waste was injected into the soil.

Bacteriological Observations

In associated studies bacterial analysis has shown that vault waste retains high viable titres of coliforms for several months after being incorporated within soil. Under the infiltration test area, low counts were found in ground water samples (fig. 2) up through November 1972, after which the tests showed zero counts. To date, no positive tests have been made of ground water under the soil incorporation area.

Laboratory tests of soil columns demonstrated that the filtration capacity of the surface 12 in. of soil was adequate even under high flushing rates. Currently, laboratory tests also are underway to determine (a) the virus filtration capabilities of the Kalkaska sand soil, and (b) the effect of treating the vault waste with hydrated lime before soil incorporation.

Chemical Observations

Local observations of ammonia alone and of nitrite plus nitrate combined exceeded U.S. public health potable water standards (fig. 3). Concentrations of these contaminants under both plots increased after snowmelt in April and remained elevated until late summer. No indications of excessive nitrogen concentrations of any form were found outside the actual treatment area.

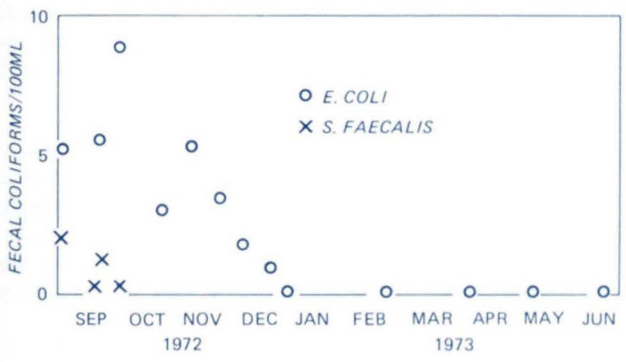

Figure 2.--*Fecal coliforms and* fecal streptococcus *in ground water under soil infiltrometer test area.*

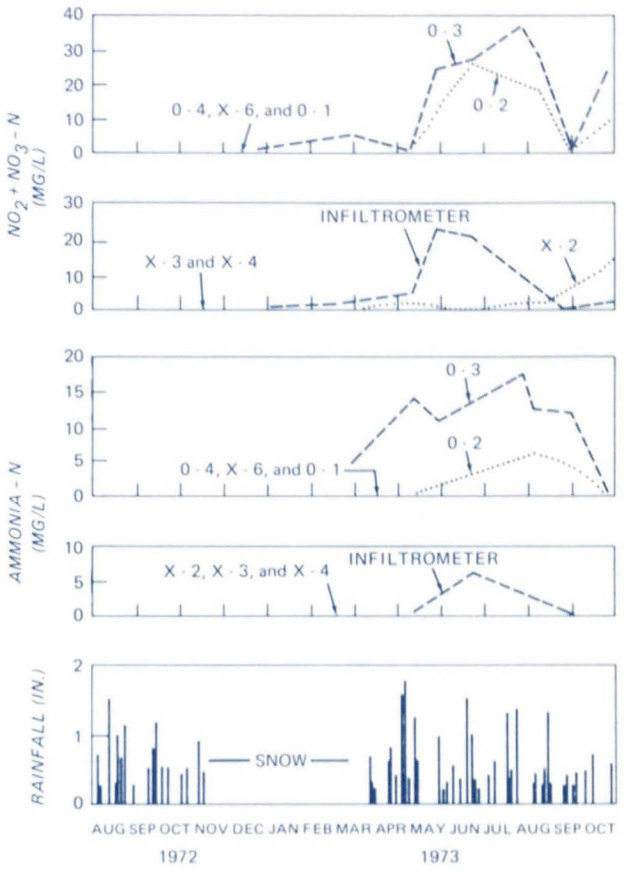

Figure 3.--*Nitrite plus nitrate and ammonia levels in ground water following soil injection tests, August 1972.*

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